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Possibilities to Increase the Size-selectivity of a Herring Trawl by Using a Rigid Sorting Grid

by

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ABSTRACT

The size-selectivity of a pelagic herring trawl equipped with a rigid sorting grid was studied in 1991-1993 in the northern Baltic Proper. Tests with different grid modifications indicate that the selection performance of a sorting grid is connected to rigging and the water flow through it. When a sorting grid is mounted horizontally with the trawl netting, the selection performance is poor, even if there is a lifting netting below the grid. With an angled grid it is possible to attain a good and sharp selection. However, to improve the selectivity of especially the smallest herring, they have to be guided out through the grid with the help of the water flow. Controlling of the water flow around and through the grid, however, has turned out to be complex and difficult task. The water flow patterns and the optimal performace of a grid are sensitive even to small changes in the rigging of the grid and the lifting/guiding panel construction.

1. INTRODUCTION

Gear Selectivity/Technical Interactions Symposium

Numbers of studies made on herring trawl selectivity indicate that by increasing the mesh size of a standard diamond mesh codend, the sorting performance can be improved, at least with low catch rates, but at the same time the loss of marketable fish may be unacceptable high due to the large selection range of a diamond mesh codend (e.g. Treschev & Shevtsov 1975, Dahm 1991, Suuronen et al. 1991, Suuronen & Millar 1992). Moreover, heavy meshing of small herring and sprat may cause time-consuming work on board (Claesson 1984, Dahm 1991, Järvik and Raid 1991). Furthermore, recent survival experiments indicate that herring escaping from a 36 mm diamond mesh codend may suffer high mortality (Suuronen et al. 1993).

In recent years much effort has been concentrated on the trials to improve the size selection of a herring trawl by modifying the shape of the codend meshes. According to these experiments, a square mesh codend releases more juveniles than a diamond mesh codend of equal mesh size (Shevtsov 1988, Dahm 1991, Suuronen & Millar 1992). However, experiments also show that under commercial catch rates a square mesh codend is seriously blocked by the fish bulk, i.e., the selectivity of the codend will be impaired in the later part of the tow (Dahm 1991, Suuronen & Millar 1992). Moreover, handling of a square mesh codend with high catches has proven to be difficult especially on stern trawlers due to the non-elasticity of the filled codend. The stretching and the knot slippage of the meshes of a square mesh codend after few hauls causes serious practical problems, and also change the selection performance of the codend. The general conclusion of a square mesh codend and other mesh configurations has been discouraging in spite of the improved selectivity with low catches.

On the whole, the experiments conducted so far suggest that in order to improve the selection performance of a pelagic herring trawl under commercial trawling conditions, new designs and modifications should be tested. A concept of using metal grids for sorting undersized fish out of trawls has recently been presented in Norway (e.g. Larsen 1990). Several practical advantages achieved by a sorting grid compared to mesh selectivity was immediately observed. Preliminary underwater observations suggested that the escape of herring through a sorting grid is easier than wriggling through a codend mesh (Suuronen 1991). For selecting small herring out of the trawl, a sorting grid is an obvious alternative to the conventional mesh selection. The recent survival trials on Baltic herring suggest that the survival rate of fish escaping through a grid might be higher than that of fish escaping from a codend (Suuronen et al. 1993).

This paper presents the fishing trials conducted with different type of sorting grid modifications in 1991-1993 in the northern Baltic Proper.

2. MATERIAL AND METHODS

2.1 Fishing trials

Trials were conducted in the Archipelago Sea (ICES Subdivision 29N), in 35-60 m waters around Nauvo on standard herring midwater trawls equipped with different sorting grid arrangements. The headline height of the trawls was on average of 18-20 m. Fishing was conducted at an average towing speed of 3.0 knots (var. 2.8-3.3 knots), at the upper layer of maximum fish concentration. In 1991 and 1993, all hauls were made by a training trawler "Harengus" (300 hp, 25 m), and the experiments were usually connected with the herring survival trials (Suuronen 1991, Suuronen et al. 1993). In 1992, all hauls were made by a hired commercial trawler "Mia" (850 hp, 32 m).

During the fishing trials in 1991, the codend and the codend extension of the trawl was constructed of a small meshed netting (16 mm stretched). A 16 mm (stretched) control bag was fitted over the sorting grid in order to collect the fish sorted out by the grid. In 1992, the codend and the control bag were constructed of a 20 mm netting.

2.2 Grid modifications

The rigid sorting grid tested in spring and autumn 1991 was constructed of four rectangular pieces (each 50x80 cm) made of stainless steel bars, the total length being 200 cm. The diameter of the hollow bars was 13.5 mm and the bar distance was 14 mm. The grid was installed in the front panel of the extension piece (Fig. 1). To compensate the weight of the steel grid, floats were mounted on the both side of the grid.

In spring 1991, the grid was fitted parallel (horizontally) to the netting on a two-seam selection unit (Grid 1). A lifting panel made of a 10 mm square mesh was installed below the grid (Fig. 1). Three different lifting panel alternatives were tested: a) no lifting panel, b) lifting panel up to the half of the unit and c) lifting panel in the uppermost position leaving only a 20 cm passage for the fish. In total, seven short hauls were made with an average catch rate of 130 kg per haul.

In autumn 1991, a four-seam selection unit (box) made of a 16 mm square mesh netting (stretched) was constructed (Fig. 1). The basic idea behind this system was to ease the mounting of the different kind of grid and lifting panel arrangements. In the first trials, a horizontal grid with a lifting panel was tested (Grid 2). Seven hauls with an average catch rate of 150 kg were made. In the second trials, an angled grid (grid angle about 45 degrees) with no lifting panel was tested (Grid 3), and four short hauls were made with an average catch rate of only 20 kg.

In autumn 1992, the grid was constructed of three pieces (each 50x80 cm) made of aluminium bars (diameter 12 mm) with a bar distance of 14 mm and a lifting panel below (Grid 4, Fig. 1)). Altogether six hauls were made. The average catch per haul was 920 kg (variation 183-2294 kg). One haul was also made with a grid having a 12 mm bar spacing (an angled rigging). The catch was 1450 kg.

Generally, a sample of 400-600 fish from each codend and control bag were measured in length to the nearest half centimeter.

2.3 Water flow observations

In addition to fishing trials, the performance of the grid modifications and the behaviour of fish relative to them was studied by an underwater video camera (S.I.T.) mounted on a towed, remote-controlled foil. Observations were carried out both during daylight and in the evening.

No actual flow measurements were made. However, with help of fish swimming patterns, shape and behaviour of netting panels around the grid and plastic ribbons hanged on the grid bars some valuable information of the flow patterns around the grid was obtained.

A pilot test with a special "flow booster" (Fig. 2) constructed of a small grid and a canvas, was conducted in autumn 1992. The purpose of the device was to increase the water outflow through the grid.

2.4 Splitted codend trials

In order to study catch and fish size distribution inside the codend, the last 10 metres of the codend (16 mm) was divided in two equal halves, upper and lower parts. Eleven hauls were made with different towing times (10 min to 2 hours) in spring 1993. The two halves were switched frequently. The average catch per haul was 150 kg.

3. RESULTS

3.1 Herring escape behaviour through a grid

During the numerous underwater observations, herring were seen to swim through the bars of the grid at a considerable high speed, mainly through the front part of grid. Passage occurs with relative ease, head usually pointed forwards. Obviously the fish can take advantage of the long (50 cm) and smooth escape "slits" of the grid, which clearly give them more time to orientate and swim compared to wriggling through an open codend mesh. It appeared that the escape was assisted by the water flow through the grid. Large herring were seen to force their heads between the metal bars in an attempt to get out. Depending on the width of their head bones, some of them succeeded in escaping while the others slid along the bars into the codend. Occassionally, some small herring were seen to swim into the codend without making any serious attempt to escape through the grid. Underwater observations revealed no indications of scale losses on herring when escaping through a sorting grid.

3.2 Selection performance of different grid arrangements

The horizontal sorting grid mounted in a two-seam selection unit (Grid 1) showed poor selection with all the three different lifting panel arrangements (Fig. 3). Generally, only an average of 40 % of the fish in the length range of 6-16 cm were sorted out through the grid. Moreover, there was a decreasing trend in the sorting performance in the smallest size groups (<11 cm). The results clearly show that the selection performance of this type of grid arrangement is very poor and the position of the lifting panel has no crucial effect on the performance.

The selection performance of the second horizontal grid modification (Grid 2) is slightly better than that of Grid 1. However, the selection is still poor; on average only 50 % of the fish in size groups 9-16 cm were sorted out (Fig. 4). The selection in the smallest size-groups had slightly increased compared to the first design.

The basic idea behind the Grid 3 and 4 modifications was the angled rigging. The Grid 3 performed well with fish larger than 11 cm, but there were still slight problems in the smallest size groups (Fig. 4). On average, 80-90 % of fish in size groups 6-16 cm were sorted out, and the selection was very sharp. The selection performance of the Grid 4 with the lifting/guiding panels was slightly better than that of the Grid 3, especially in the smallest size groups (Fig. 4).

3.3 Water flow patterns and fish behaviour in relation to sorting grid

The main problem with horizontal rigging of a sorting grid seems to be the insufficient selection in all size groups, and especially in the smallest groups. Majority of fish are obviously driven by the water flow down into the codend. Consequently, to attain a good selection with a horizontal grid, the water flow should be guided out through the grid with help of a lifting panel. However, due to e.g. the flexibility of lifting/guiding panels, the effects enforced by them are likely not sufficient and are difficult to control. Figure 5 illustrates the effect of a lifting panel on the water flow through the grid.

The selection performance of the angled grid was better than that of the horizontal grid. The better selectivity is likely a result of a more effective water flow through the grid (Fig. 6). However, in Grid 4, the lifting/guiding panels seemingly reduced the water flow inside the whole selection unit and caused disturbances in the flow patterns (Fig. 7). As a result, there were observed serious accumulation of the fish in front of the grid, indicating increased water flow through the netting in front of the grid and a remarkably decreased flow into the codend.

Underwater observations of the "flow booster" mounted in the bottom of the selection unit suggested that with help of this kind of device, it is possible to reduce the turbulence caused by guiding panels and speed up the water flow through the grid.

3.4 Effect of bar spacing on the selectivity

The percentages sorted out by the 12 mm and 14 mm grid clearly demonstrate the effects in the selectivity caused by the bar spacing (Fig 8). The two millimetres difference in bar spacing causes a remarkable difference (about 4 cm) in the mean selection length. Obviously, the 14 mm bar distance is slightly too large for retaining all the marketable (length >17 cm) herring. On the other hand, the 12 mm bar distance is too small to release all the small, unvaluable herring. In this context, it should be pointed out, that there was only one haul with the 12 mm grid.

3.5 Effects of catch rate on the selection

During the underwater observations the grid was never observed to be seriously blocked by the fish, even when there was considerable high catch rates (1000 kg per hour). In the selection trials made in autumn 1992 (Grid 4), there were generally no obvious difference in the selection performance in the hauls with different catch rates (Fig. 9). However, in the smallest size groups (<10 cm) there are some indications of an impaired selection with higher catch.

3.6 Upper/lower codend catches

In the splitted codend trials, the total catch of herring in the upper codend was 1245 kg and in the lower 400 kg. More than 80 % of the small herring (7-13 cm) and 50-75 % of fish in size groups 14-22 cm were caught by the upper codend (Fig. 10). This general swimming pattern of herring has also been observed during numerous underwater observations. This unequal distribution may, of course, depend on the trawl construction and rigging, but also on the biological factors. Anyway, this knowledge can be used in developing more effective sorting grid modifications.

3.7 Practical aspects

Generally, the grids were easily handled onboard the trawler even in adverse weather conditions. However, the tension and stress caused by the grid on the netting especially when the grid was taken on the drum gave birth to stretching and even to slight damages of the meshes around the grid. These problems could be avoided by mounting the grid with elastic ropes to the netting and making the net stronger around the grid. Obviously, the rectangular, flat shape of the grid is not optimal. A grid with rounded edges could be more suitable.

In this study, the pieces of the grid (each 50 cm) were laced together by ropes in order to obtain a bending construction. However, in the commercial trawling trials in 1992 these elements turned out to be too long when taken on the netdrum with the trawl. According to the present experiences, an element of about 35 cm long in a standard midwater trawl could better resist the pressure and stress caused by the trawl during hauling on the drum. This length would still perform well, at least in a herring trawl.

The question of the optimal material of a sorting grid is still open. Steel is heavy and expensive, but strong and smooth. Aluminium is light and cheap, but likely not strong enough. In the future trials, plastic materials, for instance glass-fiber, will be tested.

4. CONCLUSIONS AND FURTHER PLANS

During these experiments, the factors affecting on the selection performance of a sorting grid could be revealed. However, the selective performance and the practical characteristics of the sorting grid tested are not optimal yet. On the basis of our experiments it can be concluded that all arrangements which could guide the water flow through the grid would likely be helpful in developing an optimal grid construction. On the other hand, all structures causing turbulent water flow around the grid should be avoided. A sketch of an optimal arrangement of flow patterns in the selection system based on our experiments is presented in Figure 11.

References:

Claesson, B. 1984. Meshing in pelagic herring trawls. ICES C.M. 1984/B:5, 4 p. (mimeo).

Dahm, E. 1991. Doubtful improvement of the selectivity of herring midwater trawls by means of square mesh codends and constructional modifications of diamond mesh codends. ICES C.M. 1991/B:2. (mimeo).

Järvik, A. & Raid, T. 1991. The problem of meshing in Baltic herring trawl fishery. In: Proceedings of the International Herring Symposium, Anchorage, Oct 1990, p. 533-544.

Larsen, R.B. 1990. A new approach of size selectivity in commercial codfish trawls using the "Trollex" system. ICES WG on Fishing Technology and Fish Behaviour, Rostock, April 1990.

Shevtsov, S.E. 1988. Selective properties of trawl codends with various mesh shapes for Baltic herring fishery. ICES C.M. 1988/B:10. (mimeo).

Suuronen, P. 1991. The effects of a rigid grating on the slection and survival of Baltic herring - Preliminary results. ICES C.M. 1991/B:17, (mimeo).

Suuronen, P., Millar, R. & Järvik, A. 1991. Selectivity of diamond and hexagonal mesh codends in pelagic herring trawls: evidence of a catch size effect. Finnish Fish. Res. 12: 143-156.

Suuronen, P. and Millar, R.B. 1992. Size-selectivity of Diamond and Square Mesh Codends in Pelagic Herring Trawls: Only Small Herring will Notice the Difference. Can. J. Fish. Aquat. Sci., 49: 2104-2117.

Suuronen, P., Lehtonen, E., Tschernij, V. & Orrensalo, A. 1993. Survival of Baltic herring (*Clupea harengus* L.) escaping from a trawl codend and through a rigid sorting grid. ICES Fish Capture Committee C.M. 1993/B:14. (mimeo)

Treschev, A.I. & Shevtsov, S.E. 1975. Selectivity of trawl codends in fishing for herring in the Baltic Sea. ICES C.M. 1975/B:8. (mimeo).

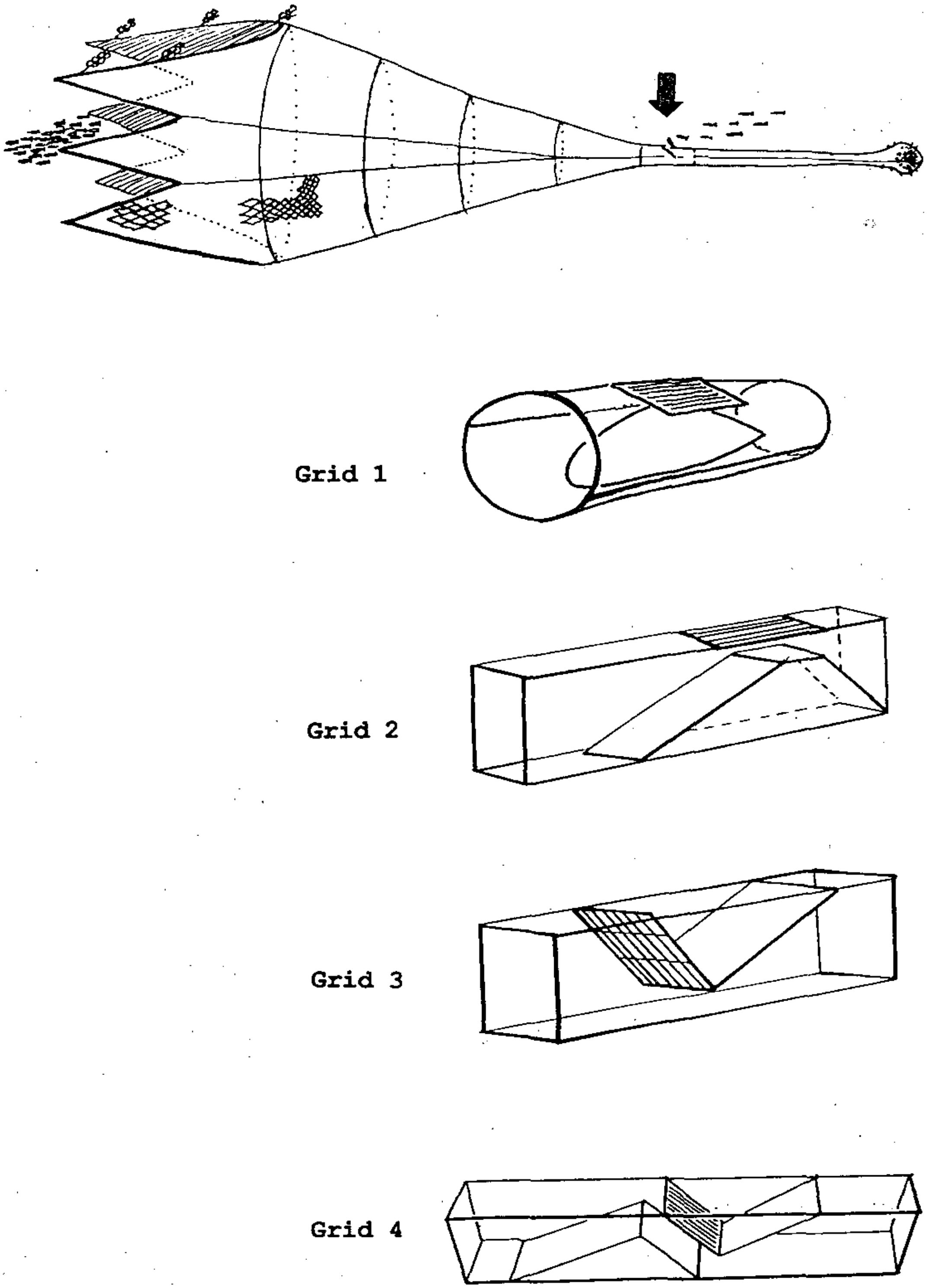


Figure 1. Overall designs of a herring midwater trawl and sorting grid modifications tested in 1991-1992. **Grid 1**: The grid is mounted parallel the netting in a two-seam selection unit. A small-meshed lifting panel is mounted below the grid. **Grid 2**: A horizontal grid (with a lifting panel below) *mounted in* a four-seam selection unit. **Grid 3**: An angled grid construction without lifting panel. **Grid 4**: An angled construction with lifting/guiding panels.

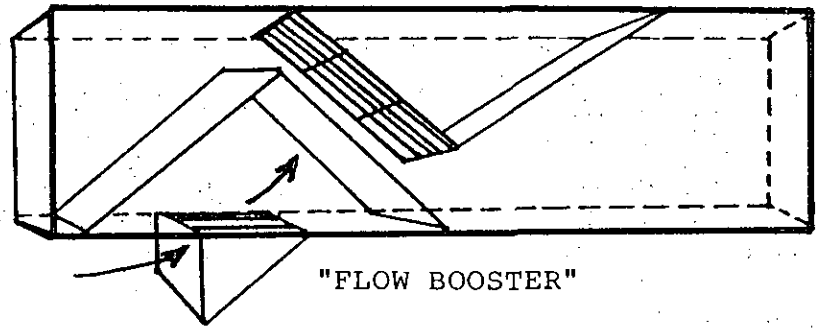


Figure 2. A special "flow booster" made of a grid and canvas was mounted in the bottom of the selection unit in order to speed up the water flow through the grid.

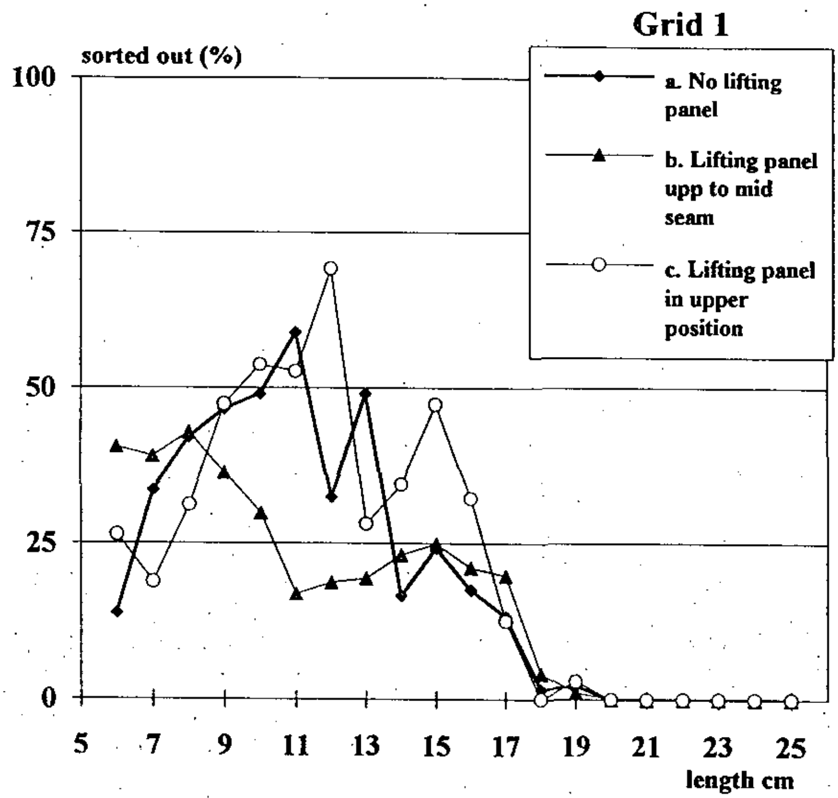


Figure 3. Percentages sorted out by the rigid sorting grid (**Grid 1**) mounted horizontally in the upper panel of the trawl extension. Three different lifting panel alternatives (a-c) were tested.

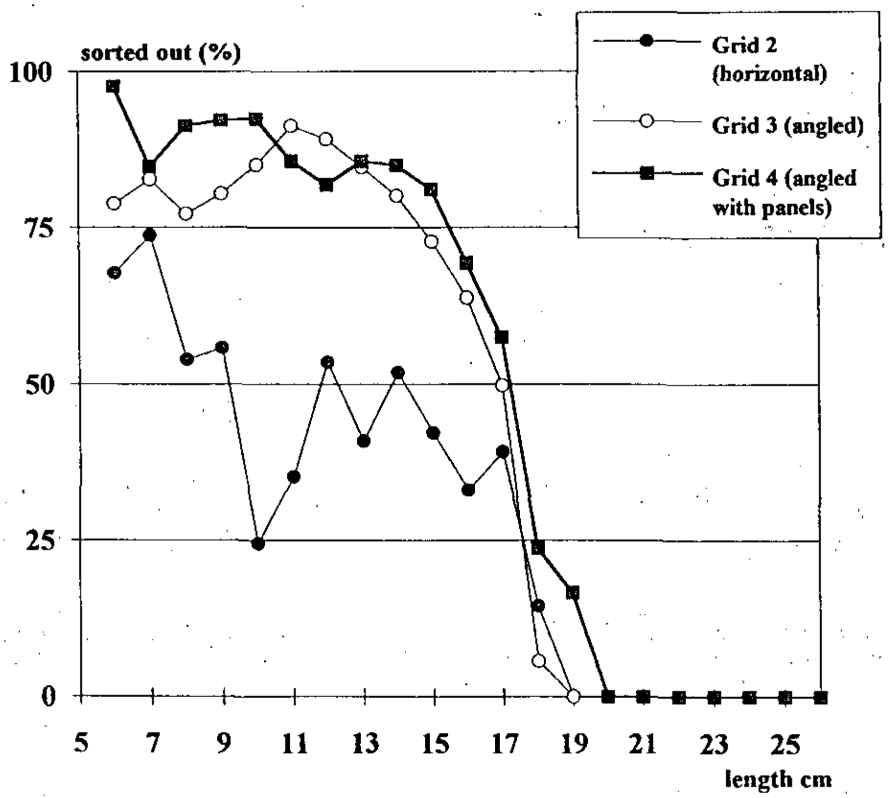


Figure 4. Percentages sorted out by the different sorting grid modifications (Grid 2, 3 and 4).

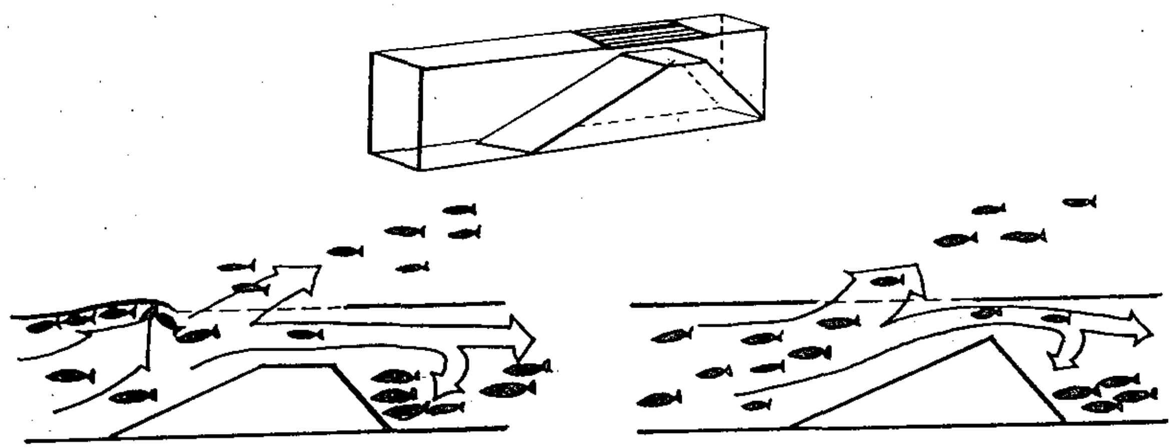


Figure 5. The effects of a lifting panel on the water flow through the grid. When the lifting panel is too close the sorting grid, there will be a turbulent flow in front of the panel, and a large part of fish will be guided against the nettings (left). When the panel is a bit behind the grid, the outflow will be undisturbed and the fish will be sorted out more effectively (right).

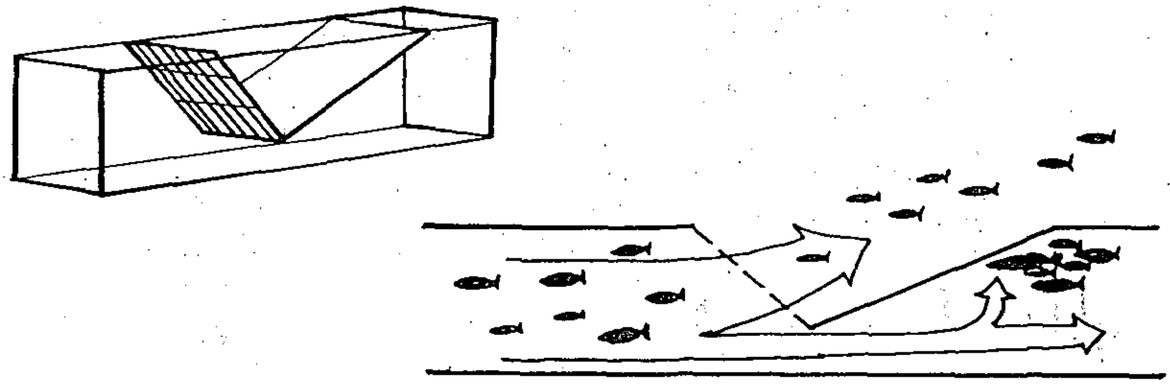


Figure 6. The water flow through an angled grid is effective when there is no disturbing elements around the grid.

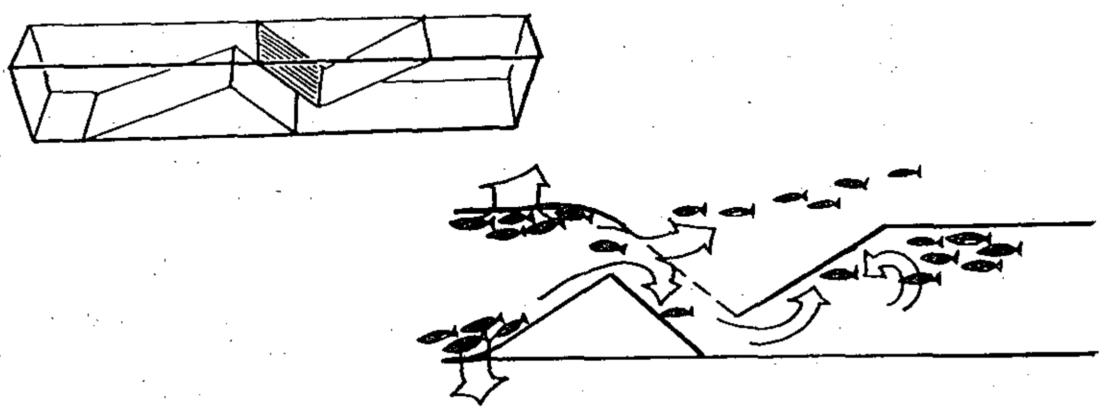


Figure 7. A lifting/guiding panel system will cause disturbances in the flow patterns and serious accumulation of fish in the nettings around the grid.

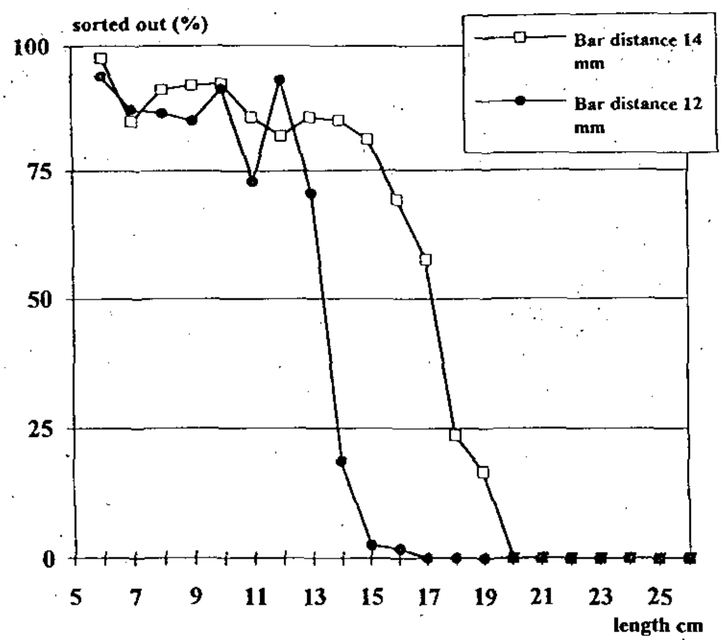


Figure 8. The effect of bar spacing on the percentages of herring sorted out by the gid.

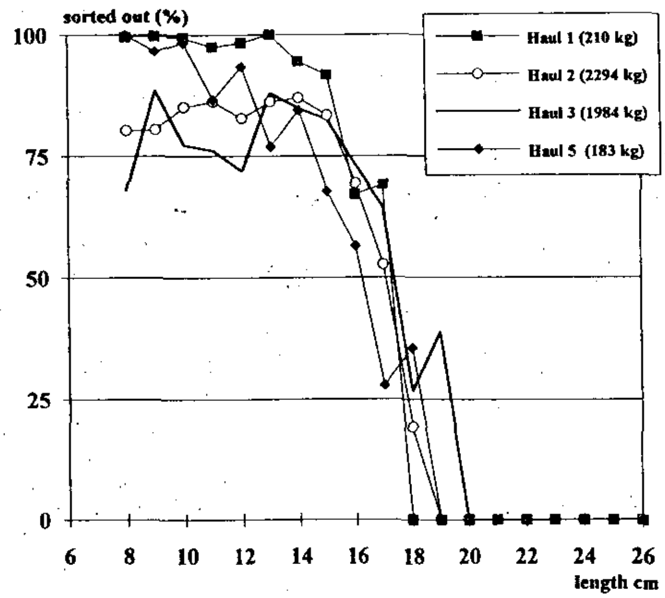


Figure 9. Effect of catch rate on the percentages sorted out by the grid (only four hauls with highest and smallest catches are presented). Catches in each haul are presented in parentheses.

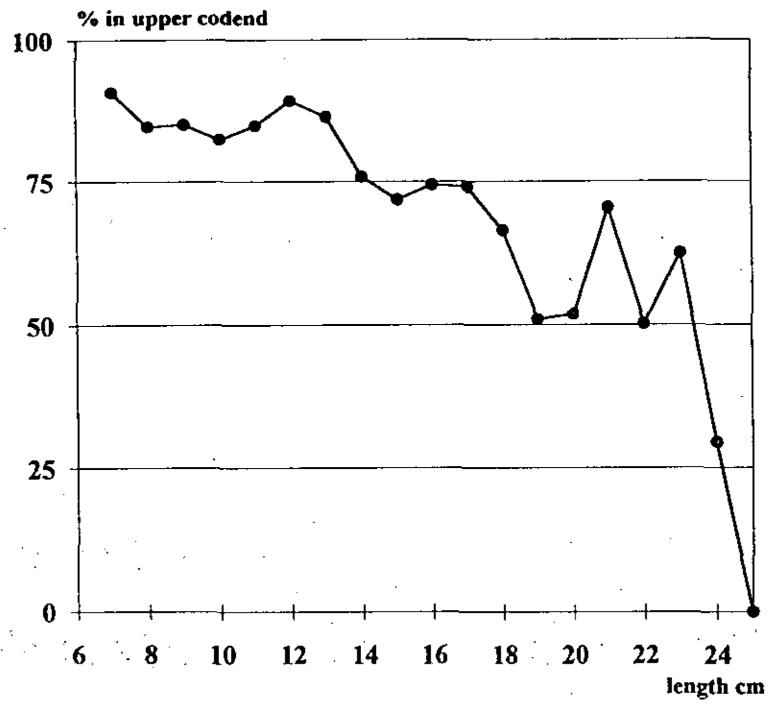
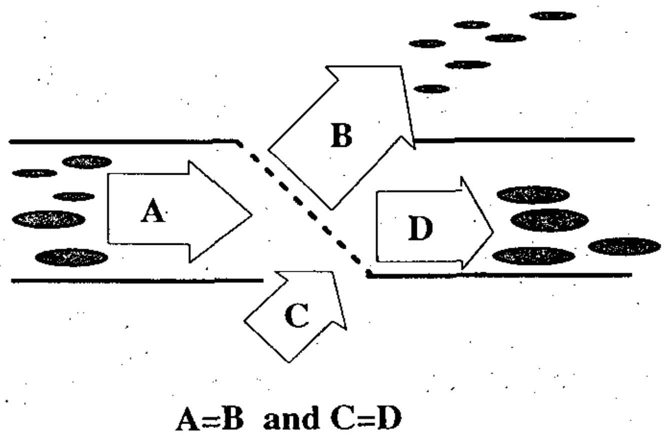


Figure 10. Percentage of herring caught in the upper codend in different length groups.



A = Undisturbed water flow in codend extension in front of the system

B = Maximal outflow through the grid

C = Inflow to replace the outflow (to reduce turbulence)

D = Sustained flow to codend

Figure 11. A sketch of an optimal arrangement of flow patterns in the selection system.